

THE CLAIMS

What is claimed is:

1. A semiconductor structure comprising:
 - a semiconductor substrate of a first material comprising germanium or a Group(III)-Group(V)-semiconductor or alloy thereof;
 - a crystalline epitaxial graded buffer layer upon the first material; and
 - a crystalline epitaxial substantially relaxed layer on the buffer layer wherein the buffer layer is sufficiently relaxed to provide relaxation of the substantially relaxed layer deposited thereon.
2. The structure of claim 1 wherein the graded buffer layer has a concentration of germanium that decreases between the substrate and the relaxed layer.
3. The structure of claim 2 wherein the first material is germanium and the concentration of germanium in the graded layer decreases from 100 percent germanium to about 40 to 80 percent germanium.
4. The structure of claim 3 wherein the relaxed layer has a substantially constant silicon concentration of about 20 to 60 percent.
5. The structure of claim 1 wherein the semiconductor substrate comprises at least one of a single crystal germanium wafer, a single Group(III)-Group(V)-semiconductor wafer, a substrate having an epitaxial germanium layer, or a substrate having an epitaxial Group(III)-Group(V)-semiconductor layer.
6. The structure of claim 1 further comprising at least one crystalline epitaxial strained layer on the relaxed layer that is composed of a second material which is different from the first material.

7. The structure of claim 6 wherein the strained layer is a silicon layer.
8. The structure of claim 6 wherein the strained layer is less than 50 nanometers thick.
9. The semiconductor structure of claim 1 further comprising:
an insulator layer; and
a base substrate, so that the structure is a crystalline epitaxial substantially relaxed layer on an insulator.
10. The structure of claim 9 further comprising a strained crystalline epitaxial layer on the insulator layer or on the substantially relaxed layer.
11. The structure of claim 9 further comprising a weakened zone in the substantially relaxed layer.
12. The structure of claim 10 wherein at least one of the buffer layer and the relaxed layer comprises carbon.
13. A method for fabricating a semiconductor structure which comprises:
growing a crystalline epitaxial buffer layer on a substrate that includes a first material comprising at least one of germanium or a Group(III)-Group(V)-semiconductor or an alloy thereof, wherein the buffer layer contacts the first material; and
growing a crystalline epitaxial substantially relaxed layer on the buffer layer wherein the buffer layer is sufficiently relaxed to provide relaxation of the substantially relaxed layer.
14. The method of claim 13 wherein the first material is germanium and the germanium concentration through the buffer layer decreases from 100 percent to about 40 to 80 percent.
15. The method of claim 14 which further comprises growing a relaxed layer with a substantially constant silicon content of about 20 percent to about 60 percent.

16. The method of claim 13 further comprising growing on the relaxed layer at least one crystalline epitaxial strained layer of a second material which is different from the first material.
17. The structure of claim 16 wherein the strained layer is a silicon layer.
18. The method of claim 13 which further comprises providing a weakened zone in the buffer layer to facilitate transfer of at least the relaxed layer.
19. A method for fabricating a semiconductor structure which comprises:
growing a crystalline epitaxial buffer layer on a substrate that includes a first material comprising at least one of germanium or a Group(III)-Group(V)-semiconductor, wherein the buffer layer contacts the first material;
providing a further layer on the buffer layer; and
providing a weakened zone in the buffer layer to facilitate transfer of at least the further layer.
20. The method of claim 19 wherein the buffer layer includes a graded layer and a substantially relaxed layer.
21. The method of claim 20 wherein the weakened zone is provided in the substantially relaxed layer.
22. The method of claim 21 wherein the further layer is an insulator layer, so that the insulator layer and part of the relaxed layer can be transferred.
23. The method of claim 22 which further comprises bonding the insulator layer to a base wafer, and detaching along the weakened zone in the relaxed layer to form a semiconductor structure that includes a portion of the relaxed layer, the insulator layer, and the base wafer.
24. The method of claim 23 which further comprises growing a strained crystalline epitaxial layer on the portion of the relaxed layer of the transfer structure.

25. The method of claim 21 wherein the further layer is an epitaxially grown strained layer.
26. The method of claim 25 which further comprises providing an insulator layer on the strained layer.
27. The method of claim 26 wherein the weakened zone is provided in the boundary plane between the relaxed layer and the strained layer and which further comprises bonding the insulator layer to a base wafer.
28. The method of claim 27 which further comprises detaching along the weakened zone in the boundary plane to form a semiconductor structure that includes the strained layer, the insulator layer, and the base wafer.
29. The method of claim 28 which further comprises selectively removing any residual portion of the relaxed layer on the strained layer.
30. The method of claim 29 wherein the strained layer is less than 50 nanometers thick.
31. The method of claim 24 further comprising heat treating the structure.
32. The method of claim 19 wherein the weakened zone is provided by implanting atomic species after depositing the further layer.
33. The method of claim 19 further comprising doping the buffer layer and/or the relaxed layer with carbon to have a carbon composition at a level below one percent.
34. In a method for providing a substantially relaxed layer on a semiconductor substrate, the improvement which comprises growing an epitaxial graded buffer layer of germanium-silicon on the substrate starting from 100 percent germanium to 60 percent germanium and 40 percent silicon, wherein the buffer layer is sufficiently relaxed to provide relaxation of the substantially relaxed layer thereon and is present in a thickness that is less than that of a silicon-germanium buffer layer.

35. The method of claim 34 which further comprises growing a substantially relaxed layer on the graded layer.
36. The method of claim 35 which further comprises growing at least one crystalline epitaxial strained layer on the relaxed layer.
37. The method of claim 34 wherein the semiconductor substrate comprises at least one of a single crystal germanium wafer, a Group(III)-Group(V)-semiconductor wafer, a substrate having an epitaxial germanium layer, or a substrate having an epitaxial Group(III)-Group(V)-semiconductor layer.